THE TELEGRAPHIC JOURNAL.

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TELEGRAPHIC FINANCE.

THE customary capital account presented to Parliament by the Comptroller and Auditor-General has afforded one of our daily contemporaries a further opportunity of carping at the telegraph expenditure of the Post-Office. It seems high time that the public mind should be directed to the true issues of the question. The administrators of our telegraph system are precluded from defending their own acts in the public press, and the discussion of a purely financial question of this character, scarcely falls within the scope of the columns of a technical journal. Nevertheless, there are certain general facts so patent that he who runs may read. *Ex parte* statements only have hitherto appeared. The debtor side of the account has been shown, but not one word has been said of the creditor side. It may be true that the revenue has fallen short by over £100,000 of the amount required to pay interest on the capital borrowed, but what have the public benefitted by this expenditure? Does the public itself complain? We have carefully examined this report, and we fail to perceive any error committed, any defect of administration exhibited, or any evidence of "lavish magnificence." £584 4s. 2d. was relinquished "as a compromise in settlement of all claims on the other side." It is not suggested that this was improper or extravagant, but that it was done "without even taking the trouble to refer to the Treasury for advice or permission."

The Report of the Auditor-General is presented to Parliament annually, pursuant to a recent Act. It is, however, regarded by the public generally as some exceptional document called forth by persistent *laches* on the part of the Post-Office Telegraph Department. It is no such thing. The Auditor-General is compelled to make this report as a matter of ordinary routine, and his duty appears to be simply to see that the charges made in the annual accounts are properly sanctioned by the Treasury and Parliament. He has nothing to do with their propriety or necessity: these are determined by the Treasury.

The head and front of all the complaints made against the Post-Office authorities is that expenditure has been incurred without the necessary constitutional authority. The most adverse critics have never suggested either wasteful or unnecessary expenditure. Many persons think that a high price was paid to the Telegraph Companies, but many other private companies, especially Gas Companies, have since been purchased by local authorities at much higher price. The Railway Companies have made outrageous and exorbitant claims, but in no case—so far as we can make out from a Return laid before Parliament—has a Railway Company succeeded in obtaining through arbitration more than the Post-Office was willing to give by agreement. Moreover, the claims made are being dealt with strictly in accordance with the Acts of Parliament, and before a tribunal above reproach or question. The public, we conceive, has received the fullest possible value for its outlay, in the shape of an improved, widely extended, and more stable telegraph service. The gravest offence committed by the Post-Office that we can trace is, that it has been too energetic in the service of its master—the public.

Telegraphic finance is divisible into two heads, viz., capital and current expenditure. The first was closed about a year and a half ago, on an undertaking of the late Prime Minister, and the second is necessarily incurred in maintaining and upholding the efficiency of the system. To carp at the first is to beg the question. The telegraphs have been purchased by the State, the public generally are very well satisfied with their bargain, the sums required for the purchase have been defined and supplied by Parliament, and no voice has yet been raised against the policy or advantage of that acquisition.

The fact that the annual nett receipts derivable from telegraphs do not at present suffice fully to pay the interest on the loans raised to acquire them, is no doubt a fair subject for comment and criticism. As a Journal interested in Telegraphy, we watch with anxiety for further information on this point. The natural growth of telegraphic business must shortly convert deficiency into surplus. Moreover, it is not fair to parade a deficiency of £100,000 a year without considering the equivalent which the nation receives. Besides the introduction of a cheap and uniform tariff, the telegraph has been carried to every considerable village in the three kingdoms, and that not merely to the railway-station or its outskirts, but to the very centres of population and business. A swift and reliable service has supplanted what was, in many cases, a slow and intermittent service. A costly and dilatory porterage has been replaced by a comparatively free and rapid delivery. A system of news despatch has been established on principles so liberal and perfect that the daily newspapers—even in the most distant provinces—are able, by its aid, to print reports, extending to many columns, of events occurring within a few hours of the time of publication. This could not have been possible

under any private system of commercial telegraphy, for the unification and re-arrangement of wires effected under the scheme of postal telegraphs have alone rendered it possible.

The Government has organised a telegraph administration that is a model for all countries to imitate, and it has succeeded in acquiring a revenue which at any rate exceeds working expenses; and the natural increase in the business itself, as well as the perfect manner in which that business is conducted, lead up to the confident expectation that the time is not far distant when financial equilibrium will be established.

THE VOLTAIC BATTERY.

A Course of Six Lectures,

By Dr. JOHN HALL GLADSTONE, F.R.S.,
Fullerian Professor of Chemistry, Royal Institution.

Delivered at the Royal Institution of Great Britain.—Christmas, 1874-5.

(Continued from p. 113.)

Lecture V.—Electrotyping, &c.

I want—in the remainder of the lecture to-day, and in the next lecture—to speak of the practical applications of the voltaic battery.

You are all aware, I dare say,—at least every girl and every boy ought to be aware,—that if you get hold of a truth it generally has some use, or outcome; if you get hold of a falsehood it is barren, it is useless or worse than useless to yourself and to those round about you. If you find a real fact it will abide by you, and you can turn it in one direction or another, and make it useful in various ways. It is the same with a true or a false theory. I spoke of that in the last lecture—did I not?—with regard to the theory of Galvani and the theory of Volta. Galvani's theory as to why his frog kicked was an incorrect one, and produced very little result. It would never have produced these beautiful things that we have upon the table here; but Volta had a better theory—a truer view. I do not say that it was perfectly true, but it was a nearer approach to the truth; and that theory became productive, and led people to think and work in various ways, and so we have these great results, and all these beautiful applications. Remember, then, that it is a great thing to get hold of a true fact or a true theory—great not only in itself, but also in the results that flow from it.

There were various early results from the galvanic battery. One thing that Davy tried was this:—You know that the bottoms of ships are coppered, in order to protect them from the water and from the things that are in the water. You know, too, perhaps, that the copper wears away gradually, and, of course, as copper is a costly thing, it was desirable, if possible, to protect the copper sheathing of the ships; and Davy thought that if he put various pieces of zinc about the copper, the zinc would dissolve and the copper would not. He tried it with what were called "zinc protectors," on the copper sheathing of the ships, and no doubt with very good effect, because the zinc did dissolve, and the copper was protected, in the salt water of the sea. That you can all understand, as you know something of electrical decomposition. But there was one disadvantage. He found that, as the copper did not dissolve, it became a famous place for all sorts of zoophytes, and algæ, barnacles, and protozoa to grow upon; and as the ship went through the sea it became a living forest of all these things belonging to the vegetable and animal world. This was very inconvenient, and retarded the ship, and so these protectors had to be taken away, when, of course, the copper—wearing away as before—was not covered so much with these living creatures of the sea. That was an application that brought an unsatisfactory result.

Another application was this—and I do not know why it ceased to be used. It may, indeed, be used still for anything I know. Some of you tried, I dare say, when you went home after the first lecture, an experiment with the zinc plate and copper held on the two sides of the tongue, and you found that there was an unpleasant flavour. Now the nurserymen took advantage of that property for use in gardens, and they thought that they could prevent soft animals climbing up their trees. I will draw a sketch of the arrangement:—Suppose we have a plant growing up. The plan was to put round the stem a little band of copper, and then a band of zinc. Then as the creature crawled along,—a snail, or slug, or caterpillar,—when the little fellow was on the copper, and put his head forward, he came upon the zinc; he did not like it, and at once threw his head back; but he tried it again, and still he did not like it: so at last, after various attempts, he turned tail, and went down the plant again.

The galvanic battery has been applied sometimes to machinery, and we have machines which can be worked by it. Here is one which I will set going with a little battery, consisting of two cells of Grove. There it goes. It depends upon the forming of temporary magnets. Magnets are made and unmade in rapid succession. Now the machine is going fast, and making even more noise than before. But there is a great deal more noise than work in this case: you will find that if we touch it in any way it will immediately stop. The difficulty is that we get very little mechanical work out of a galvanic battery. These machines are simply toys, and any attempts which have been made to apply the voltaic battery to large machinery have failed. The fact is that it is very much cheaper to burn coal in a steam-engine than to burn the coal in order to reduce the zinc which is dissolved in the battery. However, there is no mistake about the power being capable of production, and, of course, we can drive any sort of machine we please. Here is a little locomotive—a jolly little thing, which carries its own battery. It is a bichromate of potash battery. There are two carbon plates and zinc between, and the bichromate of potash solution is put in this cell. I have simply to lower the zinc, and there it goes. It takes itself along very well; but if we had a train of carriages attached to it I think it would be puzzled to go on. I dare say it would hardly run over my notes. Oh, yes, it will. I do not apprehend, however, for the reasons I mentioned to you just now, that we shall ever be going along our railways by means of galvanic batteries. Coal must be used in reducing zinc, and we can employ it better for making steam. How-

ever, there are many mechanical actions which do not require any strong power, and for those purposes it is useful. It has been applied to clocks, and by the kindness of Sir Charles Wheatstone we have an electric clock in the ante-room. Sometimes clocks have been made to work originally with electricity, but I do not think that these are so good as clocks which are merely regulated by electricity. We can attach a clock of this sort to other clocks, and thus we can employ common cheap clocks, and keep them timed by our standard clock by means of electricity. These clocks are employed for dropping time-balls and firing time-signals in different towns of England, and this is done very easily.

But another application of the galvanic battery, which is more common by far than its application to clocks, is the ringing of bells. Here I have a series of bells, and here is a Leclanché battery of two cells. I believe Mr. Murray told me that this battery has been going for a couple of years. The value of this particular kind of battery is that it only works when it is wanted, and it wears out very slowly. We have only to touch any of these knobs, and the battery sets something ringing. It has also brought out this mark —"Office." That shows that the bell is being rung from the office. We touch this other knob, and a bell is set ringing, and we bring out the word "Study," so that we see that the bell is being rung from the study. By merely pushing these knobs we make contact, and thus are able to ring the bell.

But a much more important application of the galvanic battery is to electrotyping, and to electro-plating and electro-gilding, and to that subject I invite your attention during the remainder of our hour.

You may recollect that I have already spoken to you about the simple electrotyping trough, and how we can copy medallions. This is such a trough as any of you can employ. It is sold in the shops at a cheap price. There are some still cheaper; but I have not brought a cheaper one here, though some of my own juveniles, with myself, tried one yesterday; for while we succeeded in making medallions we did not think they were quite good enough to present before you to-day. However, with this apparatus I have no doubt that we can easily prepare what we want. Here are the zinc and the medals, and there is the porous cell. Then we put the medals in a bath, and we pour into this bath any solution of copper. We put into the porous cell bisulphate of potash, or common salt if we please, and the zinc will dissolve in that. This is a copper wire, by which we can join to the piece of zinc any of these medallions we like, and then we have them hanging down at the side. A gradual change will take place, which is represented in the diagram, where you see the medallion hanging down. A change is taking place, and the copper is being deposited on the medallion, while the zinc plate—which is in the other cell—is being dissolved up at the same time. Any of you can try that if you like. We have some things which have been prepared in this way. Here, for instance, is a little medallion of Wellington. This has been just taken out, and there is the medallion with a rough outside; but there is no doubt about the perfection and smoothness of the impression itself. Probably it will be well just to pass round some of these for you to look at. But you understand that we never get any galvanic effect at all unless we have perfect conduction. The medals which are employed must conduct the force, and the liquid must conduct the force. Therefore, at first, it was supposed that it might be easy to copy a medal or a coin, but that it would not be possible to copy other things which are not conductors. But there was one great discovery made which brought about the copying of other things besides metallic bodies, and it is a discovery upon which, I think, an insufficient amount of attention has been bestowed. Without that discovery it would have been impossible for us to produce all these effects which we obtain now by the electrotype. Some discoverers have patented their inventions, and made large fortunes by them; but the gentleman who made this discovery —a friend of mine, long passed to his rest—did not think it worth while, or did not care to patent it. He, at first, merely announced it, I believe, at a Soirée in this Institution. It was Mr. Robert Murray—the father of Mr. Murray who lent me those bells and some other things in the room. This great discovery enables us to turn either a plaster of Paris cast, or a gutta-percha mould, or a wax mould, into a conducting surface. This great discovery was the application of black-lead to the surface of the cast or mould. You know black-lead, or plumbago, or graphite. It goes by those various names. Here are some fine specimens of that black-lead; but the black-lead which is employed in electrotyping is in a state of powder. Now black-lead is a very good conductor of electricity, and we have simply to rub these moulds over with it. Here is a gutta-percha mould which is somewhat elastic. Any of you can prepare the moulds like this, and there is no difficulty in getting black-lead at home and rubbing it over the moulds. You have then a conducting surface. Then you twist your wire round the mould, and if you like to varnish the back of the mould so much the better. Take care not to cover the back with black-lead. Place it in the bath, and in the course of an hour you will have the mould covered with copper where it has been covered with black-lead. If your first attempts are not successful, try again, and then you will be rewarded with success, and success which comes at last after a few failures is more valuable than success which comes in the first instance. When you have deposited all you want, lift off the copper with your thumb-nail, trim it with a pair of scissors, and then you can burnish it up and put a polish on it, or you can afterwards —by the process I shall describe to you presently—cover the medal with silver. You can turn it into a silver medal instead of a copper medal, or if you prefer gold to silver, as some people do, you can turn it into a gold medal.

Now that is the simplest kind of cell in which you can produce this electrotyping. In practice it is often actually carried on for commercial purposes in that way; but if you do not want the electrotyping on a large scale it is better to employ a separate battery. This is a small Smee's cell. You may take any other battery you like. It is better not to employ too strong a battery; but any of the forms will answer. The Smee and the Daniell are, however, perhaps the best for this purpose, because they act constantly, and comparatively slowly. You place across your trough a

band of metal, and then you can hang upon it any of your moulds by means of wires. You must do something else besides hang the moulds, because although you may put sulphate of copper in the bath, the sulphate of copper will grow weaker and weaker as the process goes on, and the supply must be kept up. The thing to do is to put a sheet of copper inside the liquid for the one pole, and then for the other pole, which is in connection with the zinc, you place your mould. Here we have a mould with a portrait of Rubens, and here a medal is formed. This has been going on since last night, and I see that it has got a very good coating of copper over it. At the end of the lecture we will open it and see how it looks.

But of course you may make a great many other things besides medals. For instance, if we want to take an engraving we can do it by this process. Here are some woodcuts I have had made. The figures have been cut into the wood. Here is a mould of wax which has been taken from the wood, after having been pressed by hydraulic pressure upon it. Then this wax mould was properly blackleaded, and it was put into a bath like this. I went over the works of Messrs. Knight and Hall, in which the thing was done, and saw the process. Of course the apparatus which we have here does the electrotyping only on a small scale; but at those works baths are employed as large as this table, and you may see, perhaps, a hundred things being coated at once. Large masses of copper are being dissolved at one end, while the metal is being deposited at the other. Here is one of the thin plates which were deposited upon the mould. You see it takes on one side perfectly the pattern of the mould, and on this side we have rough crystals of copper. Afterwards the impression is "backed up," as they term it, with other metals, and then it is employed for printing. The thing which was printed from this was the picture of the crystals which you have had put into your hands. I determined that this engraving should be electrotyped, in order that those papers should be examples of the art of electrotyping as well as representations of the crystals which I showed you on the screen. Of course it is possible not merely to deal with such things as these, but to electrotype printing type in the same way. If we set up common type we can take a wax mould from the type as in this case, and then we can get a copper deposit upon it. Here is a deposit sticking still to the mould. It is rough, you see, at the edges, and requires a little skill to remove it. Here is a deposit which has been removed. It has black-lead on one side, and bright copper on the other side. Then what is to be done is to back this up with a strong piece of metal and wood, and then after framing it and removing any imperfections, we can use it as a stereotype plate, and print from it to any extent we please.

Now this process is coming into use very largely indeed, both for the reproduction of engravings, and for the printing of magazines and books. But of course this power which we see reproducing engravings in this way may be employed for many other purposes. We can copy works of art; such, for instance, as some of these bronze figures which we have here. Here is a bust of my old teacher, Liebig—a good likeness of him. It has been kindly lent to me by Dr. Hugo Müller. It is a thick copper bust which has been produced by the electrotype. Here is an electrotype reproduction of an antique bronze of Hercules and the stag. Hercules is not there, but the stag is. This other figure is Caractacus. These have been done by Messrs. Elkington. I hold in my hand a copper bar. You see what soft copper we can produce by voltaic deposition. It can be bent round and twisted, and we can cut it easily; or we may have the same metal in a brittle and crystalline form. Here is a plaster of Paris mould instead of the gutta-percha or wax moulds which I showed you, and there are some things which we reproduced from the plaster. This thick rail of copper is one of the cylinders used in calico printing, and it is engraved by means of this art. The process is very much the same as I have already described to you. Or, if we like, we can take a smooth copper roller of this sort and put varnish upon it in the form of a pattern, and corrode away the parts not varnished.

This art has also been employed for copying many things in nature as well as in art. For instance, this is a reproduction of a piece of leather—pigskin, in fact. Anyone who looks into this will see that it is not any human imitation, but there is the real moulding of nature, and there is no mistake about it. Here is an electrotype taken from a frog, and we have got here all the different markings of the batrachian's skin very perfectly. Messrs. Elkington have sent me this beautiful photograph of a basket filled with natural ferns, coated with gold, silver, and copper, which was presented by them to the Princess of Wales. We can take ferns and cover them over with a delicate coating of copper and preserve them in that way, and very pretty they look.

But I must speak of other things. We can deposit not merely copper and bronze, but other metals too. Mr. Walenn has kindly furnished me with some specimens of what promises to be a very interesting application. This is copper deposited upon iron. This was the first piece of the kind he ever produced. It is a little iron basin with the copper deposited upon it. He places a piece of copper in the bath, and he uses cyanide of potassium and tartrate of potash, and the copper gradually dissolves in those salts, and is deposited slowly and toughly on the iron. Here are some specimens which exhibit this deposit on the iron. In order to show how closely it sticks to the iron I may say that you can scarcely separate the one from the other. You can get a very thick deposit of copper, not at all of a brittle or crystalline character; and you can see that the copper is about as tough and uncrystalline as any piece of copper which you see anywhere. Of course it can be hammered as any other piece of iron, or copper, or brass. You can dissolve brass in your bath in the same way; in fact, it is almost impossible to say what metals you may not deposit in this manner. Mr. De la Rue has sent me this very delicate specimen. It is a representation of the corona during the eclipse of the sun. In order to render that plate more durable it has been covered with an exceedingly thin film of iron, and this has been removed in one part so that you can see the copper beneath. You can see, too, how exceedingly thin the film of iron is. But that thin film of iron gives additional strength and sharpness to the engraving.

Then we can take other metals, for instance silver, and deposit them. If we want to treat silver in this way, we must take a solution of cyanide of silver and potassium—argento-cyanide of potassium, which can be prepared by the battery or otherwise. And then we have to work with that much in the same way as we worked with the sulphate of copper, employing a battery or a machine like this (Gramme's). In the large works of Messrs. Elkington, the patentees of this art, or of others who practise it, they suspend a piece of silver in the bath and make that one electrode, and at the other end they suspend their teapots, or spoons, or anything else they wish to cover with silver. These articles are made of nickel alloy, what is called German silver; but you may take almost any metal you please; though some metals require a different manipulation. If we take nickel —this white metal, or German silver—the pure silver is deposited very easily, and more strongly on the prominent parts, and less strongly in the interior parts. I ought to say that great care must be taken, when you are working in this way, to have your moulds perfectly clean. In electro-plating, I believe, it is exceedingly important that everything should be perfectly clean, and that you should cover over your metallic mould first of all with a little layer of mercury, by dipping it for an instant into nitrate of mercury, and then the mould with the mercury upon it is capable of taking the silver very easily. The silver attaches firmly to it, and by proper management it may be deposited either in a bright condition or in a dull condition, as we wish, and more or less quickly. All this depends upon the art of the manufacturer. Of course you may find out many ways in which you can modify your results. The articles may afterwards be burnished, and you may produce any polish you like upon the plating. Supposing you want to plate with gold, you must take auro-cyanide of potassium instead of argento-cyanide of potassium. The process is substantially the same. The only real difference is that you have to employ warm solutions in order to get a good effect with gold. Silver is deposited in cold baths—gold in warm baths. I ought to state that if you want to cover an article with gold, it is first covered with silver, and then the gold is deposited on the silver. If you wish to produce such things as we have upon the table, which are partly silver and partly gold, you cover the whole of the article with silver, and then you protect with varnish those parts upon which no gold is to be deposited. The article is then put into the bath of gold, and the gold is deposited upon the unprotected portions, while upon the varnished portions nothing is deposited. Here we have gold and silver figures of horses which have been covered over with this dark-coloured varnish, which has been allowed to remain upon them. By such means as these we are able to produce various effects—such effects as are exhibited in the beautiful specimens which are arranged upon the table. I am indebted to Messrs. De la Rue for a great number of these specimens of electrotyping, and to Mr. Walenn, and others. And I ought to mention especially my indebtedness to Messrs. Elkington and Company for these bronze statues, and for the fine display of beautiful works of art in electro-plate and electro-gilding which are now exhibited on the table in front.

THE ROYAL INSTITUTION.

Notes of a Course of Seven Lectures on Electricity. By Professor Tyndall, LL.D., F.R.S.

February—March, 1875.

(Continued from page 126.)

Notes of Lecture VI. *March* 11, 1875.

1. Lichtenberg devised a means of revealing the condition of an electrified surface by dusting it with powder. Red-lead, in passing through muslin, is positively electrified; flower of sulphur is negatively electrified. Whisking a fox's brush over a cake of resin, and drawing over the surface the knob of a Leyden jar, positively charged, the resin is rendered in part negative and in part positive. Dusting the mixed powder over the surface, the sulphur arranges itself over the positive places, and the red-lead over the negative places, a very beautiful figure being the result. The figures produced by the positive electricity are quite distinct in form from those produced by the negative.

2. This experiment of Lichtenberg's constituted the germ of Chladni's important acoustical researches "Chladni's figures" were the direct offspring of "Lichtenberg's figures."

3. Cadogan Morgan, in 1785, sought to produce the electric spark in the interior of solid bodies. He inserted two wires into wood, and caused the spark to pass between them: the wood was illuminated with blood-red light, or with yellow light, according as the depth at which the spark was produced was greater or less. The spark produced within an ivory ball, an orange, an apple, or under the thumb, illuminates these bodies throughout. A lemon is especially suited to this experiment, flashing forth at every spark as a speroid of brilliant golden light. A row of eggs is also brilliantly illuminated throughout at the passage of every spark from a Leyden jar.

4. At an early period efforts were made to determine the direction in which the electricity moved. When a card, or a pack of cards, was perforated by the electric spark a burr was formed both at its place of entrance and its place of exit from the card. This indicated the operation of a power acting in two directions rather than in one direction.

5. We have already illustrated Franklin's cascade battery, in which the outer coating of each jar is connected with the inner coating of the next following jar. In the ordinary battery all the inner coatings are connected together, and all the outer coatings are connected together. Such a battery acts as a single large jar of extraordinary dimensions.

6. Wires are warmed by a moderate electric discharge, by augmenting the charge they are caused to glow. The heat developed is proportional to the square of the quantity of electricity (measured by the unit-jar). With strengthened charge the metal is torn to pieces; fusion follows; and by still stronger charges the wires are reduced to metallic dust and vapour.

7. For such experiments the wire must be thin. Without resistance we can have no heat, and when the wire is thick we have little resistance. The mechanism of the discharge, as shown by the figures produced, is different in different wires.

The figure produced by the dust of a deflagrated silver wire on white paper is especially beautiful.

8. When the discharge of a powerful battery is sent through a steel chain several feet in length, the lateral scattering of the particles of the chain and their combustion in the air constitute a brilliant and instructive experiment. Chain cables have been fused by being made the channels of a flash of lightning.

9. Retaining our conception of an electric fluid, at this point we naturally add to it the conception of *a current*. It is the electric current which produces the effects just described. In many of our former experiments we had electricity at rest (static electricity); here we have electricity in motion (dynamic electricity).

10. Sending the current from a battery through a flat spiral (the primary) of copper wire, and placing within a little distance of it a second similar spiral (the secondary) with its ends connected, the passage of the current in the first spiral excites a current in the second, which is competent to deflagrate wires, and to produce all the other effects of the electrical discharge. Even when the spirals are some feet asunder, the shock produced by the secondary current is still manifest.

11. The current from the secondary spiral may be carried round a third; and this third spiral may be allowed to act upon a fourth, exactly as the primary did upon the secondary. A tertiary current is thus evoked by the secondary in the fourth spiral.

12. Carrying this tertiary current round a fifth spiral, and causing it to act inductively upon a sixth, we obtain in the latter a current of the fourth order. In this way we generate a long progeny of currents, all of them having the current first sent from the battery for a common progenitor. To Prof. Henry, of the United States, and to Prof. Riess, of Berlin, we are indebted for the investigation of the laws of these currents. These researches, however, were subsequent to—and were indeed suggested by—experiments of a similar character previously made by Faraday with voltaic electricity.

13. Franklin made an exhaustive comparison of the effects of electricity and those of lightning. The lightning flash is of the same shape as the elongated electric spark; like electricity, lightning strikes pointed objects in preference to others; lightning pursues the path of least resistance,—it burns, dissolves metals, rends bodies asunder, and strikes men blind. Franklin imitated all these effects, striking a pigeon blind, and killing a hen and turkey by the electrical discharge.

14. Having completely satisfied his mind by this comparison of the identity of both agents, he proposed to draw electricity from the clouds by a pointed rod erected on a high tower. But before the tower could be built he succeeded in his object by means of a kite with a pointed wire attached to it. The electricity descended by the hempen string to a key at the end, the key being separated from the observer by a silken string held in the hand: he thus obtained sparks, and charged a Leyden phial with atmospheric electricity.

15. But, spurred by Franklin's researches, the electrical character of lightning had been previously proved in France. A translation of his letter fell into the hands of the naturalist Buffon, who requested his friend D'Alibard to revise the translation. D'Alibard was thus induced to erect an iron rod 40 feet long, supported by silk strings, and ending in a sentry-box. It was watched by an old dragoon named Coiffier, who, on the 10th of May, 1752, heard a clap of thunder, and immediately afterwards drew sparks from the end of the iron rod.

16. The danger of experiments with metal rods was soon illustrated. Richmann, of St. Petersburg, had a rod raised 3 or 4 feet above the tiles of his house. It was connected by a chain with another rod in his room; the latter resting in a glass vessel, and being therefore insulated from the earth. On the 6th of August, 1753, a thunder-cloud discharged itself against the external rod; the electricity passed downwards along the chain: on reaching the rod below it darted from it to Richmann's head, which was about a foot distant, and killed him on the spot. Had a perfect communication existed between the lower rod and the earth, the lightning in this case would have expended itself harmlessly.

17. In 1749 Franklin proposed lightning conductors. He repeated his recommendation in 1753. He was opposed on two grounds. The Abbé Nollet and those who thought with him considered it as impious to ward off heaven's lightnings as for a child to ward off the chastening rod of its father. Others thought that the conductors would "invite" the lightning to break upon them. A long discussion was also carried on as to whether the conductors should be blunt or pointed. Wilson supported the first view, against Franklin, Cavendish, and Watson. He so influenced George III. that the pointed conductors on Buckingham House were changed for others ending in balls. Experience of the most varied kind has justified the employment of pointed conductors. In 1769 St. Paul's Cathedral was first protected.

18. The most decisive evidence in favour of conductors was obtained from ships; and it was required, to overcome the obstinate prejudice of seamen. Case after case occurred in which ships unprotected by conductors were singled out from protected ships, and shattered or destroyed by lightning. The conductors were at first movable, being hoisted on the approach of a thunderstorm: but these were finally abandoned for the fixed lightning conductors devised by the late Sir Snow Harris. The saving of property and of life by this obvious outgrowth of electrical research is incalculable.

Experiments in Lecture VI.

(1.) Note 1 was illustrated with the cake of an electrophorus. The negative sulphur formed branching and stellar shapes of great beauty on the positively electrified portions of the cake.

(2.) To connect them with Lichtenberg's figures an example of Chladni's figures was shown. Fine sand being strewn upon a brass plate a foot square, the plate was caused to emit a musical sound; the sand immediately retreated from the vibrating portions of the plate and arranged itself sharply as a system of "nodal lines," along the places of no vibration.

(3.) Two thick wires were pushed into an apple from opposite points, and brought within about ¼ an inch of each other within the apple. On causing the spark of a Leyden jar to leap over this interval

the apple glowed. The glow of a lemon under the same circumstances was particularly brilliant. A row of eggs in a tall glass jar, with its metal bottom connected with the earth, shone brightly when the discharge passed through them.

(4.) The arrangement, charging, and discharging of the ordinary electric battery were illustrated, as also the use of the unit-jar.

(5.) Seven cards were placed between the knobs of the universal discharger. After the discharge had passed through them, the central card was found without any burr. Right and left from this the burr was in opposite directions, being most pronounced in the case of the two external cards.

(6.) Wires of platinum and of silver were deflagrated, leaving the impress of the metallic dust on white paper.

(7.) The lateral scattering of the metal was further illustrated by sending the charge through a steel chain. The chain, during a passage of the electricity, bristled with lateral spikes of light.

(8.) Note 10 was illustrated by deflagrating 6 inches of silver wire by the secondary discharge. When the spirals were far apart, gun-cotton—placed between the knobs of the universal discharger—was ignited by the secondary spark.

ON TELEGRAPH CONSTRUCTION.

By JOHN GAVEY, Assoc. Soc. Tel. Engineers.

In this and the following papers, we propose, in considering the general principles to be adopted in laying out and constructing telegraph lines, endeavouring to deal with the subject in a sufficiently elementary manner, to enable those members of the telegraph staff who have little or no outdoor experience to lay the foundation of that knowledge which they may be called upon to apply practically at a later period.

1. *Selection of Route.*

The first point for consideration in dealing with the question of connecting two distant places by means of a line of telegraph is the route to be adopted. In highly civilised and thickly populated countries this question is easily settled, for well-constructed maps, giving clearly and distinctly all the physical and artificial details of the country, are readily obtainable. In England, the excellent maps, on the scale of one inch to the mile, published by the "Ordnance Survey," serve most of the practical purposes required for telegraph engineering; whilst if more minute details are needed, reference can be made to the maps on the scale of 6 inches and 25 inches to the mile, which are issued for many districts.

In very thinly populated, uncivilised, or uninhabited countries, this resource is not always to be had, and special surveys may have to be made, and rough plans of the country prepared specially, before a route is decided upon.

Assuming, then, that the maps of the localities about to be served have been obtained, a brief examination will put the engineer in possession of the various routes which lie before him, and these may be considered under the heads of ordinary roads, railroads, canals, and open country.

It will very frequently happen that the engineer will have a choice of at least two and sometimes of three of these classes of routes to select from. In such cases, however, the choice will not generally be decided by a balance of engineering advantages or disadvantages, but by expediency, or by commercial questions apart from engineering considerations. We do not therefore propose to re-discuss the vexed questions of road versus railway and canal telegraphs, but simply to describe the method of procedure in each case.

High Roads.—Having traced out the main roads connecting the two localities, obtained the approximate mileages, noted the towns and villages lying in either route, and collected such information concerning each as is generally furnished by office records, the next step is to make a preliminary inspection of the whole of them, to decide on the best line of road to be adopted. This inspection is readily made on horseback or by driving, as a sufficient knowledge of the country will be obtained in this manner to enable an officer with moderate experience to draw up a balance of advantages in favour of the best route, and much less time will be absorbed than if walking be resorted to.

Ample notes should be taken by the way of all prominent features of the country, and of all matters likely to affect the construction or subsequent maintenance of the line. Amongst the most prominent points which demand attention are the width of the roads in various localities, and the amount of waste ground, if any, on either side, jottings as to the description of soil, the banks, ditches, and trees lining the road, together with notes as to parks, mansions, family residences, &c., if these are likely to affect the construction of the line.

Indications as to the best side of the road to adopt, and the points where it should be crossed in various lengths, will materially assist the surveyor in his subsequent work. Brief notes as to the best means of passing the towns and villages on the way, may likewise be of service, and where there is reason to anticipate exceptional difficulty, or costly work, this fact should have due attention.

During the progress of the inspection, full particulars, including the names of the officers of all controlling bodies of each length of road, should be obtained; the periods and localities at which the meetings are held; and any other details likely to assist in obtaining the necessary consents for proceeding with the work. The names of large landowners also should be recorded, although time need not be lost in ascertaining the latter particulars.

This information should be embodied in the form of a schedule, giving the name and approximate length of each parish, trust, or municipal borough, together with the other details referred to. This preliminary inspection complete, the materials are furnished for forming a definite judgment as to the best route, and, commercial and traffic considerations aside, the choice should be given to that which possesses most of the following advantages:—

(1). The fewest curves, or the most gentle ones.
(2). The least encumbered with trees, without, however, being too much exposed.
(3). The fewest villages (which are occasionally very troublesome), parks, or ornamental grounds.

(4). The widest, with the largest amount of waste by the side.

(5). Other things being equal, the most sheltered from prevailing winds.

(6). A road in too close proximity to the sea, or to collieries, blast furnaces, and metal or chemical works, should be avoided when practicable.

(7). Crossing arms of the sea or navigable rivers by means of cables, is frequently a source of after trouble. It is worth adding somewhat to the length of the line to avoid this. When most, or all, of the advantages detailed can be obtained, the minimum difficulty is found in executing the work, but even when the majority of them are absent, and we cannot generally expect many for any long length, it is simply a question for the skill of the engineer to overcome the additional difficulties.

The route having been decided upon, formal application is made to the bodies controlling the roads, and their consents being obtained, the actual survey may be proceeded with.

Railways.—The preliminary investigations on a railway need be but brief. There is not, like in the case of high roads, a choice of lines, with a balance of advantages and disadvantages to decide upon. The only questions involving special consideration before the survey commences, are those connected with station buildings, large station yards, tunnels, viaducts, and steep perpendicular cuttings. These are questions which of course affect the estimated cost of the work, and for this primarily, and also to enable instructions to be given as to the method of dealing with each of these special points, is the preliminary inspection needed.

Canals.—The remarks made as to railways apply to a considerable extent to canals. Natural difficulties arising from sharp curves, confined space, numerous bridges, aqueducts, abrupt variations in level, and other points involving departure from the ordinary route, or special expenditure, have to be noted and provided for, together with, it may be, intervening stretches over roads or private property.

Lines through Open Country.—The cases in which it is necessary to erect lines through the open country for any considerable distance in highly civilised districts, are few. Even where considerable spaces of waste or uncultivated land exist, they are generally traversed by roads; and it is advisable to follow these as closely as convenient, on account of the facilities for transport, inspection, and maintenance thereby afforded. Where it becomes necessary, however, to depart widely from known roads, the natural features of the country must be observed, and the line offering the shortest route and the fewest difficulties in the shape of hills, streams, &c., together with that affording the best transport and the most shelter, must be adopted. The immediate cost of erection is not the only point to be borne in mind, but the future maintenance of the line is a question of the highest importance. It will thus be seen that unfrequented localities difficult of access, should be, where possible, shunned as increasing the difficulties in the speedy removal of faults when such arise.

2. *Survey and Consents.*

The route having been decided upon, and the necessary consents having been obtained from the controlling bodies, the question of survey next arises.

Instruments used in surveying.

The Chain, commonly called "Gunter's chain," is that most generally used in England, for measuring distances required in a survey. It is 22 yards or 66 feet long, and is divided into 100 links joined by rings. At every tenth link pieces of brass of different forms are fixed, affording ready means of counting the links. "Gunter's chain" is especially useful for measuring areas, as it forms a decimal of an acre, this being equal to ten square chains, or 100,000 square links. It is, perhaps, scarcely so well adapted for mere ordinary linear measurements, when speed, as well as exactitude, is required, especially as in telegraph surveying, where numerous short lengths have to be measured; as each link being equal to 7·92 inches, an awkward fraction is introduced in every case.

A chain of 22 yards, or in some cases of 100 feet, with links 1 foot long, is better adapted to such purposes. The chain becomes extended by constant use, and it requires occasional verification and correction by the removal of intermediate rings.

Accompanying the chain are ten arrows, which simply consist of pieces of No. 4 wire, pointed at one end, and provided with a loop at the other for convenience of handling.

Two men are needed for chain measuring, one at each extremity. The first man or leader starting with the ten arrows in his hand, walks in the direction to be measured, the follower remaining at the starting point. When the chain is fairly extended in the required direction, the leader inserts an arrow in the ground at the extremity of the chain. Both men then move forward together till the follower arrives at the first arrow. The leader then deposits a second one, the follower takes up the first, and both move on. This is repeated till all the ten arrows have been collected by the follower. The latter will then have measured ten chains. The arrows are returned to the leader, and the same operation recommences. When lesser distances than ten chains have to be measured, the arrows should be exchanged for each measurement.

The measuring tape consists of a painted tape enclosed in a cylindrical leather case. It measures 22 yards in length, is divided into feet and inches, and is wound on a small cylinder inside the case. The best tapes are technically termed "wire tapes," because a few threads of fine brass or copper wire are woven into the substance and run through its entire length. This to a great extent prevents extension and tearing, and such tapes are more exact and more durable than common ones.

Offset Staff.—These are designed primarily to measure short distances or offsets, but they serve the equally important duty of ranging staffs for plotting out the positions of the poles, running straight lines along the ground, judging the value of angles, &c.

They are usually 6 feet long, painted black and white, in 6-inch lengths, and if provided with clamps at each extremity, to admit of two or three being fitted together, they are found very service-

able for obtaining a route or direction, when intervening obstacles obscure the direct line of vision.

Notes.

It appears from the Report of the Controller and Auditor-General on the capital account of the Post Office Telegraphs, that the total cost of the Postal Telegraph system up to the close of the financial year 1872-3, was £9,085,458.

The Derby result this year numbered over 1400 messages. During the four days of the meeting, some 13,500 messages were dealt with at the Epsom Post Office and the Telegraph Office at the Grand Stand, of which 1650 were for the Press. On the Derby day the total number of messages approximated 4500, being an increase of 300 on the number for the corresponding day the preceding year. On the Oaks day the number was 3200, being an increase of nearly 500. In 1870, the first year after the Post Office acquired the telegraphs, the Derby day produced barely 1600 messages, whilst the total number for the week was hardly in excess of that dealt with on the Derby day of the present year.

The following is from the Cuba Submarine Telegraph Company (Limited):—Information has been received of the interruption of the cable between Punta Rassa and Key West, connecting the West India Islands and Panama with North America. Telegrams are being conveyed by steamer, at an average delay of about one day.

In concluding his lectures "On Chemical Force," at the Royal Institution, Professor Gladstone, F.R.S., described a series of experiments recently made by himself and Mr. Tribe by means of what is called the copper-zinc couple. When thin sheets of zinc are immersed in a solution of cupric sulphate, copper is deposited upon it in a minute state of division, and thus the two metals touch at myriads of points. When this couple is immersed in a binary liquid, the liquid at each point of junction is exposed to the full chemical or electromotive force of the metals. It was shown that this obviates the great difficulty there often is in decomposing a liquid on account of the "resistance" which it offers, and the lecturer exhibited the breaking up in this way of pure water, iodide of ethyl, chloroform, and many other substances with the production of pure hydrogen, zinc ethyl, hydrides, &c., and several bodies previously unknown, some of which are spontaneously inflammable in the air; in fact, one substance which had never been made before was prepared expressly for the lecture, and was named zinc ethylo-chloride. The copper-zinc couple has been practically applied to the production of certain organic compounds, and to the determination of nitrates in potable waters.

The fourth International Telegraph Conference was opened at St. Petersburg on the 1st June by General Timaschew, Minister of the Interior, who delivered an address to the members, concluding with an assurance that the pacific feelings expressed by the Emperor are the unanimous aspirations of the Russian nation. Signor d'Amico, the Italian delegate, replied on behalf of his colleagues.

We are informed by the Great Northern Telegraph Company that, according to information received from Foochow, an agreement was entered into and signed there on the 21st May, between the Chinese Government, represented by the Imperial Commissioner Shen Panchen, Viceroy and General in the Province of Fookien, charged with full powers by Tsung-li-Yamen, Minister for Foreign Affairs in Pekin, and the Great Northern Telegraph Company, to the following effect:—The Chinese Government pays the Company full compensation for the damage done to the Foochow-Amoy line in January last. The Company to erect a line of telegraphs between Foochow and Amoy for account and use of the Chinese Government. Inland telegraph stations to be established in Amoy, Foochow, and the two intermediate towns, Hinghua and Chuenchau. The working of the line to be undertaken by the Company for account of the Chinese Government.

At a recent Board meeting of the Anglo-American Telegraph Company, it was resolved that on and after the 2nd of June the estimated gross receipts of the Company for the previous day be posted daily at the offices.

Although the traffic returns now exhibited by the Anglo-American Telegraph Company show a falling off compared with the corresponding period when the 4s. tariff was in force, the cheaper rate is beginning to tell in the increase of messages. The daily average earnings last month were £1095 against £1813 in May, 1874, when the charge was 4s. per word, so that the reduction of 50 per cent in the tariff only involved a loss of 38 per cent in the receipts. On Wednesday last the receipts were £1400 against £1240 on the previous day, while the daily average in that month last year was £1959. The decrease was thus only 28 per cent, the diminution in charge being 50 per cent. On Thursday the receipts were £1340, and on Friday £1350.

At a meeting on Monday, June 7, at the City Terminus Hotel, of the Eastern Extension, Australian, and China Telegraph Company, the following Resolutions were passed:—"1. That the report of the Directors recommending the extension of the telegraphic system of the Company to New Zealand be and is hereby adopted, and that the Directors be and are hereby authorised to proceed with such extension, and to enter into all necessary contracts, and to do all necessary acts, to effect such extension. 2. That the Directors be and are hereby authorised to enter into such agreement or agreements, or make such other arrangements as they shall think fit, on behalf of the Company, with the Hon. Sir Julius Vogel, on behalf of the Government of New Zealand, for defining and settling the terms and conditions of telegraphic communication by the Company with that Colony."

The traffic receipts of the Eastern Telegraph Company for the month of May amounted to £30,602, against £30,225 at the corresponding period of 1874; and of the Eastern Extension, Australasia, and China Telegraph Company, to £17,773, against £18,879 last year.

The traffic receipts of the Brazilian Submarine Telegraph Company (Limited) for the month of May amounted to £12,080.

The number of messages passing over the Cuba Submarine Telegraph Company's lines during the month of May (including those received at the new station at Cienfuegos) was 2481, estimated to produce £2400, against 1788 messages, producing £1851, in the corresponding month of last year. The actual receipts for the three months ending March amount to £7153 as compared with the estimated amount of £7100.

The Direct United States Cable Company announces the completion of through communication with America by means of their cable. Further particulars will shortly be given.

The traffic receipts of the Direct Spanish Telegraph Company (Limited) for the month of May, amounted to £1442 9s. 2d., against £1494 14s. 6d. in April.

The Secretary of the Direct Spanish Telegraph Company (Limited) informs us that the average time occupied in the transmission of telegrams between Madrid and England, *via* Santander, during May, was three hours and twenty-six minutes (including transmission over Spanish land-lines).

The traffic receipts of the Great Northern Telegraph Company for the month of May were—this year, 366,423 francs; last year, 363,932 francs. Total traffic receipts, 1st January to 31st May—this year, 1,602,397, francs; last year, 1,689.998 francs.

UPON THE

INDUCED CURRENTS PRODUCED BY THE APPLICATION OF ARMATURES TO HORSE-SHOE MAGNETS,

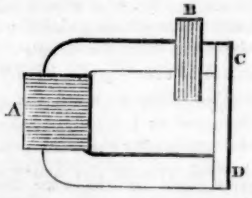
AND A

NEW FORM OF MAGNETO-ELECTRIC ENGINE.

By W. R. MORSE.

The apparatus consisted of cylindrical horse-shoe electro-magnets, the wires of which were wound about the iron cores at the bend of the iron, so as to form practically straight electro-magnets with cores, horse-shoe in form. Upon one of the limbs of the horse-shoe core a coil of fine wire was slipped so that the plane of its coils was at right angles to those of the electro-magnet. In Fig. 1 A represents the coil of

Fig. 1.



the electro-magnet; B, that of the induction coil. Upon exciting the electro-magnet induction currents arose in the coil of fine wire B both at making and breaking the circuit. These currents were measured by a reflecting galvanometer placed in the circuit of the coil B, and were compared with those obtained from the same electro-magnet by placing a straight armature C D upon its poles and then exciting the electro-magnet. The following table shows the results obtained. Only the currents resulting from making the circuit are recorded, those proceeding from the breaking of the circuit being the same in value. The readings are expressed in the divisions of the scale of the reflecting galvanometer:—

Without Armature.	With Armature.	After Removal of the Armature. 1st Deflection.	After Removal of the Armature. 2nd Deflection.
170	210	210	170
170	209	209	170
175	209	209	170
170	210	210	175

These results show that a marked increase (in these experiments nearly 25 per cent) in the strength of the induction currents results from the application of an armature to the poles of the electro-magnet. The third and fourth columns of the table show that after the removal of the armature, the first induced current which results from again making the current in the electro-magnet, shows the same increased effect; but that the following current resulting from breaking the circuit of the electro-magnet falls to its normal amount. This result is noteworthy, for it shows a certain molecular change in the iron which results from the application of the armature.

Although we can thus increase the strength of the induction currents produced in coils slipped upon the limbs of an electro-magnet, we diminish the lifting power of these individual limbs by the employment of an armature, as the following results show:—

Weight Lifted without Armature.	Weight Lifted with Armature on.
249	160
300	180

In the preceding experiments the straight iron bars forming the armatures were carefully deprived of whatever residual magnetism they might possess.

Experiments were next tried upon the effect of horse-shoe electro-magnets used as armatures to electro-magnets of the same character as those employed in the preceding experiments. When two north or two south poles were opposed to each other, and the magnetic circuit, so to speak, of the two horse-shoe-shaped cores was closed, very feeble indications were shown by the galvanometer. When, however, a north and a south pole were opposed, and the magnetic circuit closed, the strength of the currents obtained both on the application and the removal of the armature were very marked, as the following results show:—

At Contact of N. and S. Poles.	On Removal of N. and S. Poles.
+360	−359
+362	−360
+361	−361

When the horse-shoe magnet forming the armature was not used, and one of the limbs of the stationary electro-magnet was quickly slipped in and out of the induction coil, induction currents were obtained, the values of which are shown below—

Placed in.	Withdrawn.
+40	−40
+40	−40
+40	−40

In these experiments the stationary electro-magnet and the electro-magnetic armature were of the same size and the same magnetic strength.

Experiments were next made upon the influence of the mass of iron forming the armature. This was found not to have so much influence as the residual magnetism of the iron. The results were very contradictory, as the following table shows:—

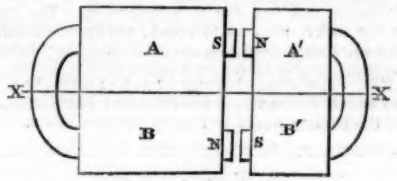
Weight of Armature. Grms.	Deflection Produced.
364	280
341	330
222	290
137	280
132	290
67	310

We are led to believe that the mass of the iron does not affect the results when it exceeds that of the stationary electro-magnet.

The induction currents resulting even from the employment of straight soft iron armatures which had been carefully deprived of residual magnetism, are thus seen to be more than four times as strong as those obtained by merely slipping the induction coil on and off the limits of the electro-magnet; which is, practically, the method adopted in many later forms of the magneto-electric engine, particularly in that of the Gramme machine, in which different portions of a ring-shaped electro-magnet revolve toward and away from the poles of a horse-shoe magnet. When electro-magnetic armatures are used, the effects far surpass those obtained by non-magnetic soft iron straight armatures, as the preceding results show.

Professor Trowbridge suggests a magneto-electric engine of the following construction:—The horse-shoe armature is made to revolve about the line X X as an axis. By the preceding experiments it has been found that when a north and a south pole are opposed, the induction currents flowing through B and A′ are in the same direction, and those through B′ and A are also in one direction. By a suitable commutator the currents circulating through the coils on the stationary magnet can be sent through those on the armatures, and *vice versa*. The residual magnetism in soft iron is sufficient to start the induced currents. Instead

Fig. 2.



of one stationary electro-magnet, it would probably be better to employ a number arranged about the axis X X. With projecting pieces of soft iron arranged upon the poles of the stationary magnets, the size of the horse-shoe armature could be regulated to suit the varying conditions of speed.

Experiments are now being made on this form of engine.—*Amer. Journ. of Sci. and Arts.*

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

The last ordinary general meeting of the session was held on Wednesday, the 12th May, Mr. Latimer Clark, President, in the chair.

The first paper read was on "*Battery Measurement*," by Mr. Frederick Hawkins, who explained a rapid and easy method of taking all the various measurements of the resistance and electro-motive forces of batteries with the same galvanometer. The *modus operandi* was explained after the meeting was over, and shown by a galvanometer in action. Mr. Hawkins has secured a larger range of deflection of the reflecting galvanometer than usual.

Colonel Stothard, R.E., subsequently read a paper on "*Earth Connections of Lightning Conductors*." It appeared that in the year 1855 a small powder magazine close to the sea coast at East London, Cape of Good Hope, was struck by lightning; the solid iron conductor was torn to pieces, and the building much damaged, but none being done to the powder. A subsequent examination showed that the iron rod forming the conductor was split up, and portions of it broken off. The conductor terminated in a dry water tank resting on soil of 12 inches of sand overlying old red sandstone. Two points in connection with the case were raised. 1. The use of tanks as a means of connecting lightning conductors with the earth. 2. The employment of iron for conductors instead of copper.

With regard to the first point, it was subsequently announced that the War Office had abandoned the termination of lightning conductors in such places as tanks. In the discussion which ensued some diversity of opinion was expressed relative to the superiority of iron over copper. It, however, came to the point that the cost as to equal conductivity was about equal, whilst the question of durability was most decidedly in favour of copper.

Mr. Preece related the extraordinary circumstances under which Mr. Pidgeon, his wife, and son, had been struck by lightning in his garden at Paignton, Torbay (an account of which appeared in *Nature*), and detailed the case; the flagstaff near which they were was broken in pieces, and various damage done. The

course of the lightning, with its bifurcations, was illustrated by diagrams, and Mr. Pidgeon himself brought further evidence to bear upon the point.

Dr. MANN, the President of the Meteorological Society, spoke at some length, and much interested the Society by his lucid explanations. The discussion was joined in by many members, but it may be remarked that, like many other cases cited, the Paignton case was due to a bad earth. The ground being rocky, and, so to speak, partly insulated, the lightning spread out in broad surface. The "Insulated Island," as St. Pierre is telegraphically known, was cited. The discussion was closed at a late hour with an announcement from the President that the meetings of the Society would be resumed in November.

Notices of Books.

The Year Book of Facts in Science and Arts for 1874. Edited by C. W. VINCENT, F.C.S., &c. London: Ward, Lock, and Tyler.

THIS is a fresh issue in a new cover of a very old and well-known annual. Mr. Timbs, its originator, has unfortunately departed, but his mantle has descended upon Mr. Vincent, who has rehabilitated and thrown fresh vigour and force into a very valuable book. There were indications in the recent volumes that Mr. Timbs's sources of information were narrow and few, but Mr. Vincent has gone wider and further afield, and the value of the book is enhanced accordingly. It is a very useful work of reference.

POST-OFFICE TELEGRAPHS.—Statement showing the total number of messages forwarded from Postal Telegraph Stations in the United Kingdom during the week ended the 29th May, 1875, and during the corresponding week of 1874:—1875, 409,008; 1874, 346,635; increase in the week of 1875 on that of 1874, 62,373.—Week ended 5th June, 1875, and corresponding week of 1874:—1875, 415,296; 1874, 385,279; increase in the week of 1875 on that of 1874, 30,017.

TELEGRAPH PAPER.—The earliest forms of telegraph instruments possessed a certain economy over those now in use. They were non-recording, and therefore did not require to be fed with endless supplies of paper like the more modern inventions. At a comparatively early stage of telegraphic history, however, paper began to be used for the purpose of recording messages. The Bain instrument, in use some twenty years ago, or more, recorded its signals in the shape of blue marks on chemically-prepared paper; and the original Morse instrument indented the signs representing the alphabet on a narrow strip of paper by means of a stile or pointer, and hence the name which has always clung to it—the "embosser." In these days of postal telegraphy paper enters very largely into both the sending and receiving operations on the wires. The extended use of the Wheatstone system has greatly increased the consumption of paper; and it seems improbable that, for some time to come at least, sounding or non-recording instruments will be introduced to such an extent as to materially alter the conditions in this respect. Telegraphic paper is of three kinds, viz., that used for the Morse, Wheatstone, and Hughes instruments respectively. Morse paper, as it is called, is that which is most in use, being equally adapted—so far as recording messages is concerned—to the ordinary Morse and Wheatstone instruments. This paper is used in a narrow strip, about $\frac{7}{8}$ths of an inch wide, and is of a greenish tint, so as to be less trying to the sight of the operator than ordinary white paper. It is usually wound on spindles about 4½ feet long and 8 inches in diameter, and afterwards cut into rolls of the width required for the instrument—namely, about $\frac{7}{8}$ths of an inch. Of these spindles, each containing upwards of 30 miles of paper, no fewer than 350 per month, or upwards of 4000 per annum, are consumed in the postal telegraph service throughout the country, so that the total annual consumption of the narrow strip must exceed 130,000 miles. The paper coil is fitted to the instrument as occasion requires, and is unwound by means of clockwork whenever the apparatus is started to receive a message. What is known as Wheatstone paper is employed exclusively in the sending process of telegraphy. It is sometimes called punching-paper, because it is perforated full of large and small holes, indicating the different signs in telegraphy, before it is passed through the transmitting apparatus. This paper is white, and is of a rather stronger texture than the ordinary Morse paper, besides being cut up into a slightly wider strip. The coils undergo a preparation in oil before being brought into use, in order that the paper may be more readily acted upon by the perforating machines; and for this purpose as many as 500 gals. of sweet oil are annually consumed in the telegraph department. Nearly 7000 miles of Wheatstone paper are used in the postal system in the course of a year, and this is obtained by cutting up into coils upwards of 300 spindles of much the same dimensions as those of the Morse paper. Until very recently all the paper used throughout the postal system was cut and dressed in the telegraph department in London. The process, in which a steam-engine and several lathes of peculiar construction were employed, was a somewhat novel one, and often engaged the attention of visitors—on one occasion that of the Emperor of Brazil, who carried off a roll of paper as a memento of his visit. A mile of Morse paper cut into the narrow strip required for the instrument only weighs 2 lbs. 3 ozs., while a mile of Wheatstone paper is nearly 1¼ lbs. heavier. The Morse paper, after being "written" or printed on, is called "slip," and after being unwound from the instrument, and the signals translated, it is rewound, labelled, and carefully filed away, in case it should be required for reference any time within the three months during which it is the practice of the Post-Office to keep all messages. These slips are a kind of "sword of Damocles" hanging over the head of the unfortunate operator who may chance to have made an error in the transmission of a message, for it need scarcely be explained that they disclose with unerring exactness whether the blunder has been made by the sending or receiving clerk. In a large office like that at St. Martin's-le-Grand many miles of these tape-like records must be constantly on hand, and if they could only be placed side by side with the corresponding messages sorted away in the vaults underneath they might tell a curious tale. The same fate awaits both the "slip" and the messages. At the end of every three months some tons of both are carted off to that mysterious "mill" of Her Majesty's Stationery Office whence no official form or document was ever known to return—in its original shape, at all events. "Pulp" is the condition to which all such matters are reduced; and if the message forms or the "slip" ever find their way back to St. Martin's-le-Grand, it is quite certain that they only return as an old friend with a new face.—*Times*.

To Correspondents.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "THE TELEGRAPHIC JOURNAL" is the organ, will always command attention. Anonymous correspondence will be wholly disregarded. Literary communications and books for review should be addressed to the EDITOR; business communications to the PUBLISHER.